BIENNIAL REPORT

OF THE

Board of State Harbor Commissioners

FOR

THE TWO FISCAL YEARS ENDING JULY 1, 1873.

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REPORT.

To His Excellency, NEWTON BOOTH,
Governor of the State of California:

The Board of State Harbor Commissioners for the City and County of San Francisco, herewith present their biennial report for the period terminating July first, eighteen hundred and seventy-three. The annexed report of the Secretary, exhibits a detailed statement of receipts and expenditures.

In accordance with an Act approved March thirtieth, eighteen hundred and seventy-two, the rates of dockage, wharfage, and tolls, and the monthly payments on all leases of the water front, were reduced fifty per cent May first, eighteen hundred and seventy-two. The receipts during the last twelve months when former rates were collected, aggregated two hundred and eight thousand one hundred and fifty-six dollars and twenty-three cents, and for the year ending July first, eighteen hundred and seventy-three, in conformity with the reduction, one hundred and sixty thousand eight hundred dollars and seventy-three cents; but it should be stated that during the term first mentioned, several wharves were held under leases, and the Board having subsequently taken possession, greater receipts were obtained.

WHARVES.

Wood is the sole material used in the construction of wharves and piers, and its perishable nature, in connection with the ravages of the *teredo navalis* and the *limnoria terebrans*, render them costly structures.

Annexed is an interesting special report of T. J. Arnold, Engineer of the Board, concerning the pests referred to, and experience has shown that wharves constructed of unpreserved material, generally become worthless within ten years, and require expenditures for repairs during the time named equal to half of the original cost.

The creosoting process for the preservation of timber, has been successful in Europe and tropical countries, and its failure to prove entirely so here where it has been partially tested, is attributed to imperfect treatment.

The piles recently driven in the enlargement of Market street wharf, were carefully prepared, and favorable results are anticipated. The attention of the Board has been called to other processes, and a willingness expressed to test their relative utility.

The report referred to, contains valuable information concerning the various modes of treatment and experience elsewhere, as to their efficacy in rendering timber indestructible. The insufficient accommodation for vessels of the largest class during a portion of last year, caused serious delays in discharging and receiving cargoes, and Market and Front street wharves have therefore been enlarged and others partially renewed, and it is believed that after the requisite dredging shall be performed, a recurrence of material delay will be avoided.

La Rue's is the only wharf under the control of the State where dockage and tolls are not collected by the Commissioners, the same having been recently assigned to the wood dealers, and the revenue received will be greater than otherwise obtained. Prior to May first, eighteen hundred and seventy-three, the Central Pacific Railroad Company occupied, for ferry purposes, the bulkhead between Broadway and Pacific wharves, and a berth at the latter, for one hundred and fifty dollars per month, and the Board, believing that greater revenue should be derived for the accommodation afforded, the company was then notified that the payment of established rates of dockage would be required, and the net receipts for two months have aggregated one thousand three hundred and thirty-four dollars and twenty-five cents. The California Pacific Railroad Company, previous to June first, eighteen hundred and seventy-three, was allowed the sole use of Broadway wharf for five hundred dollars per month, but possession was then resumed, and the net proceeds for the month were one thousand four hundred and fifty-seven dollars and sixteen cents.

DREDGING.

The expense incurred for dredging, since the creation of the Board, has been an important item, and no authority existing for the Commissioners to procure a dredger, they have been compelled, in accordance with law, to advertise for proposals for the performance of the work. The rates paid have varied from thirty-four to fifty cents per cubic yard—the last being thirty-six, and contracted for by the present Board; but the mode of computing the amount removed differs from that prevailing heretofore, and is now determined by measurement previous to the commencement of the work and after completion. The absence of competition and the excessive charges have induced the Board to limit the amount as far as consistent with the urgent demands of commerce, and authority to obtain a dredger is regarded as essential to a thorough and economical performance of the work. The constant and rapid shoaling is partially owing to the sewers emptying into the slips, and relief from this source will be referred to in suggestions concerning improvements on the entire water front.

LEASING.

In accordance with law, the wharves were advertised for lease in March last, and bids received, but the Commissioners, conceiving that the public interest would not be promoted by a compliance with the terms proposed, were induced to reject the same, and are constrained to remark, that they regard the policy of leasing generally as indiscreet. It is probable, if the property should be leased with provisions for the necessary repairs and dredging to be performed by the lessees, and the return at the expiration in like condition as received, that differences between the Commissioners and the lessees would frequently occur and lead to

protracted litigation, and sureties deemed ample might ultimately prove entirely irresponsible. Power, however, should be granted to afford permanent accommodation to ferries and steamers plying regularly inland, or to coastwise or foreign ports; and authority should also be conferred to discriminate when the revenue derived, in accordance with the ordinary rates of dockage, may prove entirely inadequate to the privileges obtained. Leases to individuals or corporations, similar to those existing, should be deprecated, as rights thus acquired may prove serious obstacles in consummating changes which may be regarded as vitally important.

SEA WALL.

Owing to the limited amount of funds in the hands of the Board available for that purpose, no work has been done upon the bulkhead during the last two years.

Of the total length of sea wall originally authorized by statute—eight thousand three hundred and thirty-seven feet—there remains a length of five thousand and eighty-five feet yet to be constructed. The plan adopted for this work, as applied to the present water front, appears to have given satisfaction. The embankment has not settled materially at any place and no lateral movement has occurred.

It will be observed that the line submitted by the Engineer of the Board for a new water front, conforms substantially with the old line between Folsom and Pacific streets; and in case this plan, or a similar one, is adopted, that portion of the embankment between Pacific and Howard streets will be made to form a part of the new work. A section, six hundred and fifty feet long, between Vallejo and Union streets, would have to be abandoned as a water front, and the work performed upon it could only be utilized as so much necessary filling. The reclamation of the water lots in the block bounded by Howard, Folsom, East, and Steuart streets, has had the effect to force a large amount of mud into the slip south of Howard street, which will have to be removed by the dredger.

To avoid the useless expense which is thus entailed, the sea wall embankment should, as soon as possible, be extended southerly from its present termination near Howard street, to a point at or near Folsom street.

OBSTRUCTIONS ON THE BULKHEAD.

Upon assuming office, the present Board found the bulkheads much obstructed by lumber, wood, and other material, and even by buildings, in some instances of considerable magnitude. Efforts to cause the removal of the obstructions have resulted in partial success, and the occupants of various warehouses and offices have signified a willingness to remove when required; but positive orders have been delayed with a view to avoid what might be regarded as unnecessary harshness. The bulkhead between Market and Howard streets is much incumbered, and the ordinary business of the vicinity impeded, and the exertions of the Board to obtain a compliance with their demands have thus far proved ineffectual.

SUGGESTIONS CONCERNING THE FUTURE.

A map of the present water front, and another, indicating what the future should be, are herewith submitted. The former delineates the

angles and lack of uniformity which cause increased shoaling, and it is evident that the curved frontage and wharves at right angles, as shown on the latter, and constructed with piers of durable materials and less in number, will prove of greater utility, and cause the current to essentially decrease the shoaling of the slips, and consequently the expenditure for dredging.

Further relief can be afforded by the construction of an intercepting sewer along the city front, and inside of the State line, of capacity sufficient to receive the sewage of the city, and to be flushed at each returning ebb tide by water to be retained in a basin or reservoir at its southern extremity. The amount of water which can be held and discharged at the times mentioned will be ample to thoroughly cleanse the main sewer, and thus avoid a prolific source of shoaling and materially promote the sanitary condition of the city.

A railway track, to be open to all companies, can be constructed along the entire water front, and afford facilities for delivering and receiving freights at the various wharves, and a considerable area north of Vallejo street can be reclaimed and utilized for depot purposes. The necessity for bringing ship and car together is realized in Atlantic ports, and improvements to accomplish the object desired are either progressing or generally contemplated, and prospectively a like necessity here cannot fail to be apparent. The expenditure necessary cannot be estimated until the extent of the improvements shall be defined, and the Board respectfully recommend the appointment of a Commission, consisting of competent engineers and others of commercial and maritime experience, to report in reference to the entire matter.

WAYS AND MEANS.

If it shall be determined to remodel the entire water front, the question will arise as to the ways and means to accomplish the change. The only resorts are the creation of a bonded debt or the imposition of an annual tax. The former is beyond the power of the State, and the latter would encounter hostility elsewhere than in the City of San Francisco.

Under these circumstances, the propriety of transferring the property to the city, coupled with restrictions that may be deemed advisable, and authorizing the issuance of bonds or a tax levy for a series of years, may receive favorable consideration.

The creation of a public debt for an object which can be accomplished by an annual imposition which would not be regarded as oppressive, is questionable, and in the event of a transfer the latter may be deemed more in accordance with sound policy. A bonded debt would require that sufficient should be realized from dockage and wharfage for the annual interest and a Sinking Fund for the extinction of the debt at maturity, while taxation for defraying the cost as the work may progress would obviate the necessity for excessive rates, and when completed, for sufficient only for dredging and ordinary repairs. The assessed value of real and personal property for the present year approximates two hundred and fifteen million dollars, and a tax of ten cents on each one hundred dollars would yield two hundred and fifteen thousand dollars, and as it would be necessary to prosecute the work by sections, and not essentially decrease the accommodation requisite for the commerce of the port, it is believed that the amount named would be as much as could be judiciously expended annually.

Less than twenty-five years have elapsed since San Francisco became a port of entry, and she now ranks as third in the collection of duties on imports. There are those prominent in her commercial marts who remember when, in early manhood, the surroundings of the harbor were in a state of nature, and the past inspires sanguine hopes of the future.

Intercourse with Eastern Asia, Australia, and the islands of the Pacific, cannot be regarded as more than inaugurated, and although corporate greed and rapacity may seek the consummation of schemes injurious to her interests, it may not prove fallacious to predict that when another like period shall terminate, she will surpass all save the great metropolis of the Nation.

For details concerning various matters the Commissioners refer to the report of T. J. Arnold, Engineer, and to that of J. F. Swift, Esq., special counsel, respecting pending litigation.

LEWIS CUNNINGHAM.
SAMUEL SOULE.
T. D. MATHEWSON.

REPORT

OF

T. J. ARNOLD, ENGINEER OF SEA WALL.

REPORT.

ENGINEER'S OFFICE, San Francisco, July 30th, 1873.

To the Honorable the Board of State Harbor Commissioners:

GENTLEMEN: I herewith respectfully submit my biennial report for the period ending July first, eighteen hundred and seventy-three.

BULKHEAD.

No work has been done on the sea wall embankment since the date of my last report. I take pleasure in saying that I have seen no reason to qualify, in any manner, the favorable opinion which I have heretofore expressed of the plan adopted by the Board for this important work. With some modifications in the specifications and careful attention to the materials used, I believe it will accomplish all that was claimed for it by its projectors. That portion of the embankment which was first constructed has settled very little, if any, in the last two years; but upon the section which was completed in eighteen hundred and seventy, I have noticed a slight settlement, which is due probably to the compacting of the material. I have not been able to discover anywhere the least lateral movement of the embankment.

WHARVES.

The total amount expended during the last two years for work performed under contract, upon the various wharves on the city front, is forty-eight thousand three hundred and forty-seven dollars and three cents, as follows:

Wharves.	Amount.
Market-street wharf	$19,273 80
Front-street wharf	7,752 50
Pacific-street wharf	6,303 20
Mission-street wharf	4,020 24
Howard-street wharf	3,515 60
Jackson-street wharf	2,881 14
North Point wharf	2,128 93
Spear and Bryant-street wharf	1,372 97
La Rue's wharf	836 60
Commercial-street wharf	143 55
Washington-street wharf	118 50
Total	$48,347 03

Market-street wharf was replanked in December, eighteen hundred and seventy-two, and in May of this year was widened from fifty feet to eighty feet, the new portion being constructed of preserved piles. At the same time ninety new standard piles were driven under the old structure. The wharf is now in good condition, and, from its position, it is one of the most important, and will undoubtedly be one of the most profitable wharves, on the city front. Pacific, Jackson, and Howard-street wharves have been entirely replanked and otherwise repaired. Front-street wharf has been widened from fifty feet to seventy-five feet, and is now capable of accommodating five first-class ships. Mission-street wharf was partly replanked in October, eighteen hundred and seventy-two, and a section of it, two hundred and sixty feet in length, is now being rebuilt by W. H. Martin & Co., under a contract with your honorable Board. The other wharves included in the above schedule have been variously repaired by planking and driving standard and fender piles where necessary.

In addition to the work above enumerated, fifty-eight thousand five hundred and seventy-five dollars and eighty-seven cents have been expended in

URGENT REPAIRS.

Making the total amount of money expended for wharves in the last two years, one hundred and six thousand nine hundred and twelve dollars and ninety cents. I find on reference to the records that the items embraced under the head of urgent repairs, are so numerous as to render a detailed statement of them in this report impracticable. The cost of nearly all the fender piles which are driven from time to time, and a great portion of the "patching," which is a source of constant expense, is included under this head. Broadway, Pacific, Washington, Clay, Commercial, and a great part of Market-street wharves were constructed upwards of eighteen years ago. The piles in some of these wharves have been renewed three times, and upon those which have sustained a heavy traffic, the planking has been replaced, on an average, every three years. The cost of repairs on Pacific-street wharf, since it came into the possession of the Board (February, eighteen hundred and sixty-seven), has amounted to a sum sufficient to build two first-class wharves of equal dimensions.

DREDGING.

During the last two years two hundred and fifty-three thousand six hundred and forty cubic yards of mud have been removed from the various slips along the city front, at a cost of eighty-six thousand two hundred and thirty-seven dollars and sixty cents, as follows :

Wharves.	Cubic yards.
At Vallejo-street wharf	56,710
At Market and Howard-street wharves	40,470
At Pacific-street wharf	26,160
At Mission-street wharf	25,780
At Market-street wharf	21,720
At La Rue's wharf	21,080
At Eureka and North Point wharves	17,530
At Broadway wharf	17,510
At Front-street wharf	16,010
At Main-street wharf	10,670
Total	253,640

The Board has recently entered into a contract with W. H. Taylor for the removal of two hundred thousand cubic yards of mud (more or less), and Mr. Taylor is now engaged in the prosecution of the work. Upon the completion of the present contract, the Board will have expended for dredging, since its organization, a total sum of four hundred and one thousand three hundred and sixty-one dollars and ten cents, as follows :

	Date.	Amount.
Amount as per biennial report of	1867	$54,406 50
Amount as per biennial report of	1869	73,359 00
Amount as per biennial report of	1871	115,358 00
Amount as per biennial report of	1873	86,237 60
Present contract		72,000 00
Total		$401,361 10

Even with this large expenditure the Commissioners have been able to do little more than to excavate trenches alongside the wharves, just wide enough and deep enough to admit vessels at high water. In the middle of the slips the mud has accumulated from year to year until it is now, in places, barely covered at low water.

In my biennial report of eighteen hundred and seventy-one, I called attention to the rapid accumulation of mud along the city front, and, in pointing out the cause, suggested what I conceived to be the only remedy for the evil, namely : a modification of the line of the water front, and the enactment of such laws as would enable the Board to construct the wharves in such a manner, and upon such lines, that they would obstruct the currents of the bay as little as possible.

The Act of March fifth, eighteen hundred and sixty-four, under which all improvements on the water front are made, is defective in several ways. It provides for the building of a sea wall upon arbitrary lines,

without apparent reference to the depth of water or directions of the currents; it exposes abrupt angles and obstacles to the ebb and flow of the tide, and, without regard to this vital element in preserving depth of water, requires the wharves to be constructed on the extension of the lines of streets terminating on the city front. The wharves so constructed, in conformity with law, are of unequal lengths, and, owing to the want of parallelism in the streets north and south of Market street, are extended at various angles with each other, causing the waterway, under the wharves, to be partially closed to the free action of the tides, and rendering it impossible to keep berths open to shipping without constant and expensive dredging.

As a fundamental proposition, it may be said that the piers should be constructed, in respect to length and alignment, with direct reference to the currents of the bay. The lengths should be graduated so that the pier-head line will conform to the general direction of the tidal path, and the piers should be located upon such lines that the supports, reduced to a minimum, will offer the least possible obstruction to the passage of the water.

A due regard to these principles, in the construction of wharves, and a rectification of the present angular water front, would, in my opinion, reduce the amount of dredging, now required to accommodate shipping, at least one half.

In view of the enormous outlay for dredging, and the constantly increasing expense entailed by the system of "patching" old wharves, to which we are driven, the practical question for the Board to consider, is: should the errors which were inaugurated before the Harbor Commission was created, and which the Act of eighteen hundred and sixty-four in effect continues, be perpetuated, or should a general and comprehensive plan be adopted which will meet the business requirements of a great city?

The time cannot be far distant when each branch of trade will demand wharf accommodations especially adapted to its peculiar requirements. Piers must be provided for steamers and vessels engaged in foreign trade, in domestic trade, in the wood and coal trade, in the trade in lumber and building materials, in the hay and grain trade, in fruit, vegetables, fish, and other market supplies, and the dimensions of each wharf, and the plan upon which it is constructed, must depend in each case upon the use to which it is to be applied. In order that cheap and rapid communication may be effected between land and water transportation—a matter of vital importance to San Francisco—provision should also be made for railroad tracks along the city front.

I submit a map showing somewhat, in detail, the general features of the plan which is here outlined.

This plan, in brief, provides for a street two hundred feet wide along the whole city front, following the curved lines, which mark the course of the tides. Two railroad tracks are shown upon this street for its entire length, with spur tracks extending out to and along the piers. Starting from this main street, the wharves are projected at right angles to the currents, and have an average length of about three hundred feet. In order to utilize the sea-wall embankment between Pacific and Howard streets, which has been completed, a slight angle is made in the proposed line, near Market street, but the length of the wharves are so graduated that the pier line along this portion of the city front is straight.

The piles in all new wharves, which form a part of this system, should be preserved so thoroughly as to render their protection against the attacks of the marine worms a matter of absolute certainty. In this respect we should be guided by the experience obtained on similar works in Europe, where piles treated by the creosote process have been found to be perfectly sound after an exposure of over thirty years.

Special legislation will be required to enable the Board to modify either the line of the water front or the plan of improvements now in process of execution. If the evils growing out of the present system are not overrated, it would seem proper that the change should be made as soon as possible. The facilities for loading and unloading vessels have been found inadequate for the accommodation of the increasing commerce of this port, and any new work undertaken under the present laws relating to harbor improvements, will be constructed upon principles known to be erroneous. The railroad policy of the city, and perhaps of the State, may turn upon the feasibility of reaching every point on the city front with loaded cars. The exact location of a new line for the water front should be determined by a careful and patient study of the currents of the bay; and in order that all possible errors may be avoided, I would suggest that before taking final action the Board should have the best engineering advice that can be obtained.

Respectfully submitted.

T. J. ARNOLD,
Engineer of Sea Wall.

REPORT

ON THE

PRESERVATION OF TIMBER.

REPORT.

ENGINEER'S OFFICE,
San Francisco, February 3d, 1873.

To the Honorable the Board of State Harbor Commissioners:

GENTLEMEN: In compliance with your instructions, I have examined the subject matter of the communication from I. C. Woods, Esq., manager of the wood-preserving works located in this city, and also that of Thos. C. Wallace & Co., and respectfully submit the following report:

The preservation of woods, by means of chemical preparations, has been the subject of many interesting experiments both in the United States and in Europe. From the nature of the investigations, the value of the several processes which have been suggested can only be ascertained by actual trial after such tests as time alone can furnish. No experiments that I have made myself can, therefore, be of any material interest; and in the discussion of the question, I am driven to the necessity of referring you almost entirely to what has been done by others. As the subject is one of great importance in its bearing upon projected improvements on our water front, I trust I may be pardoned for treating it somewhat at length.

The destruction of our wharves arises from two causes:

First—The marine worms which feed upon the piles; and

Second—The rapid decay of the Oregon fir timber composing the superstructure.

The marine worms which destroy our piles are of two kinds, namely, the *teredo navalis* and the *limnoria terebrans*.

The operations of the *teredo* have been pretty thoroughly observed by scientific men, but the habits of the worm itself have not been so well studied. So far as I know, the germ of the *teredo* seems to exist in all sea water above a certain temperature, but its presence there cannot be detected, even under the magnifying power of the most powerful microscope. It needs for its development a habitation of wood from which the bark has been removed. A series of interesting experiments were made at the Norfolk Navy Yard, prior to eighteen hundred and sixty-one, by Calvin Brown, Esq., now Government Civil Engineer at Mare Island. In the course of these experiments, he found that the young *teredo* had entered a piece of wood one eighth of an inch in thickness, which had only been submerged eight days. The outer sur-

face of the wood, under the microscope, showed no signs of perforation by the worm; but a thin shaving, planed off, exposed their holes, though not visible without the glass. Deeper excavation brought to light the worm itself, which was then so small as to be nearly invisible to the naked eye. It appeared to be a small white bulb, but under the glass it showed the perfect *teredo*. This germ would grow at Norfolk from six to twelve inches in length and three eighths of an inch in diameter during one Summer.

The *teredo* has neither legs, fins, nor other apparent means of locomotion. Its head, which is in two parts, is of the ordinary sea shell substance, and fills one end of the cavity it inhabits. The wood is bored by the head, its two parts working on a hinge, into fine dust, which passes through the gelatinous body of the worm, perhaps furnishing it food. This gelatinous body entirely fills the cavity made and inhabited by the worm. The body terminates in a flattened tail protected by a thin shell covering. At its junction with the body, the tail can be opened into two equal parts, indicating one straight intestine from the head to and through the tail. The *teredo* can at will project this tail through the hole by which it entered the wood, and this is its means of communication with the sea water. Without sea water, if allowed to remain in the wood, the worm dies in from twenty-four to forty-eight hours; removed from the wood, it dies almost instantly, and its body shrivels to a mere thread.

The *teredo* is said by naturalists to be oviparous, and that its young, immediately after birth, attach themselves to the first attainable wood, and begin to bore it. Whether they impregnate the waters of the harbor by being brought into it in worm-eaten wood, or whether after leaving the mother they remain in an imperfect condition in the water for an indefinite period, until they drift against a piece of wood floating or fixed; or whether the young *teredo* forms a living colony in the honey-combed piles, are among the habits of this destructive pest which are yet to be investigated.

In our eastern harbors, they are said to disappear during the Winter months, or at least to cease their ravages, and then to reappear or recommence their operations with the opening of Summer. In this harbor they never cease their operations, so far as we have been able to observe their habits.

The *teredo* enters the piles across the grain of the wood, between the top of the mud and ordinary low-water mark, and after entering, it bores with the grain upward as far as high-water mark, and downward to the line of the mud; but never below the line of the mud and never out again into the water.

The *teredo*, as I have before mentioned, never eats the bark of the wood, and only enters the piles after the bark has been removed.

The *limnoria terebrans* has only recently made its appearance in our waters. It comes originally from the tropics, and is brought here no doubt by vessels whose planking has been eaten by it. This worm cuts the piles entirely across the grain, eating from the outside, and making great cavities in the wood. They seem to prefer being left exposed a portion of the time by the receding tide. It eats the wood just below ordinary high-water mark.

This worm was first noticed in England in eighteen hundred and eight, by the late Robert Stevenson, and was named and described by Dr. Leach, in eighteen hundred and eleven. The following is the description of the *limnoria* as found in English waters:

"Gregarious and abundant; attacks by preference the pine family; does not attack floating wood; is from one fifth to one third of an inch long, rounded at each end, with parallel sides; has fourteen segments, the last two being the largest; the seven next to the head each bear a pair of strong mandibles which are the boring organs. General color olive gray; can swim as well as creep; when touched rolls itself into a ball like the common sow bug, which it much resembles."

This description answers precisely to the newly discovered worm which has so recently made its appearance in the waters of this harbor. Piles are eaten by them completely through, so that one piece will remain attached to the cap of the wharf while the other is found projecting from the mud. The operations of this worm may be seen at North Point and Greenwich Docks.

THE DECAY OF OREGON FIR TIMBER IN SAN FRANCISCO.

The best authorities agree as to the Winter months, when the sap is down, being the time for cutting timber, in order to secure the best quality of material which the tree is capable of producing. They also agree as to the necessity of thoroughly seasoning the same wood before using it. Our wharf material here is often growing in the forests bordering Puget Sound ninety days before it is framed into the wharf. In an exhaustive report made by Chas. R. Story, Chairman of Special Committee, addressed to the Board of Supervisors of this city, July thirtieth, eighteen hundred and seventy, upon the subject of street pavements, he uses the following language in reference to timber on this coast:

"The time of year within which trees are felled has very great influence on the durability of the wood. To secure the best qualities of the wood the tree should be felled when the sap is down, that is, in the Winter months. It is this fact which makes the Winter months the season for logging. In the East the snow forms the bed for hauling the logs, and the swollen rivers in the Spring carry the logs to market. In this country we have neither Winter nor snow, and but few rivers used for rafting; hence on the Pacific Coast, the timber trees are cut at all seasons of the year, and beyond doubt a portion of the bad reputation attaching to some species of wood is owing to this cause. Nearly all the wood brought to this market comes by vessel, green, and of course steamed in the hold, hence may be injuriously affected by this confinement. We can never bring logging to the system of Winter cutting practiced in the East, and this is an additional reason why, in San Francisco, we must resort to some wood-preserving process to protect us against decaying wood."

In our own experience, on works under the control of the Harbor Commissioners, we have found that piles are attacked by the *teredo*, as soon as the bark falls off, which is in about two years after they are driven; that fender piles are so weakened by these attacks, that in four years they will not sustain any considerable lateral pressure; that standard piles, having to sustain a vertical pressure, will last from seven to eight years, but at some risk after the sixth year, and that Oregon timber, when exposed to moisture, begins to decay in from five to eight years.

Having glanced at the causes of the rapid destruction of our wharves, I will now consider what may be done to preserve them from decay and the ravages of the marine worm.

Upwards of fifty patents have been taken out for the preservation of timber by chemical preparations, the mode of application generally being to force the solutions into the pores of the wood by pressure in close vessels. The best known, and perhaps most valuable compounds employed, are chloride of mercury, sulphate of copper, chloride of zinc, sulphate of iron, carbonate of soda, and creosote or pitch oil. While some of the metallic salts have been found to prevent dry rot, none of them appear to protect submerged timbers from the attacks of the marine worms. Professor Wood, of the Michigan University, in a recent treatise on the preservation of timber, says: "It was naturally supposed that poisoning the timber would poison or drive away the *teredo*, but Kyan's and all other processes employing solutions of the salts of metals of alkaline earths, signally failed. The constant motion of sea water soon dilutes and washes away the small quantity of soluble poison with which the wood has been injected. If any albuminate of a metallic base still remains in the wood, the poisonous properties of the injection have been destroyed by the combination. Moreover, the lower vertebrates are unaffected by poisons which kill the mammals. Indeed, it is now known that certain of the lower forms of animal life live and even fatten on such deadly agents as arsenic."

A paper read at a meeting of the Philosophical Society of Glasgow, by Mr. P. M. Moir, and published in eighteen hundred and sixty-nine, contains a concise statement of the conclusions arrived at relative to the value of the various European patents for preserving wood from the attacks of the marine worm, and is, in a measure, a summary of the opinions of nearly all recent writers on the subject. He says:

"Kyanizing, or injecting corrosive sublimate into timber, is very expensive, if properly done, and besides this, there is the fact that it is practically useless, inasmuch as it has been found that Kyanized piles after three years immersion in the sea, did not contain a trace of the preservative compound.

"Sulphate of copper, first suggested as a preservative by Margary, and afterwards largely employed by Boucherie, may be used to prevent dry rot in timber, but for piers, bridges, and other structures, which are exposed to the action of water, it has no practical value, as the water dissolves out the salts with great rapidity. Timber prepared with this salt, and used for marine purposes, is as readily destroyed by the *teredo* and *limnoria* as unprepared timber.

"In Payne's process, a solution of sulphate of iron is first absorbed into the wood, and afterwards carbonate of soda. Double decomposition ensues, and the practical result is the formation of oxide of iron, the decomposition of which renders wood brittle, and does not prevent attacks of either of the worms just named."

Professor Baird, of the Smithsonian Institute, in commenting upon a series of experiments conducted in Holland, under the direction of the Academy of Sciences, of Amsterdam, says:

* * * "Trial was made of sulphate of copper, sulphate of iron, acetate of lead, corrosive sublimate, soluble glass, chloride of calcium, and chloride of zinc, tar oil, creosote of oil, etc. Of these,

the creosote oil experiment alone presented any positive indications of beneficial result, and in it the committee found what they sought for. After five years of exposure, while all other piles, whether prepared or not, were entirely eaten up, those impregnated with this substance were perfectly sound and free from any trace of worms. * * * Impregnating wood with soluble inorganic salts which are poisonous to animal life, furnishes no protection against the worm. This is due to the fact that the sea water soon dissolves away their strength, and the worm does not devour or digest the wood bored out by means of the shelly jaws."

Attempts have been made to find insoluble deposits in the interior of timber by first injecting a solution of one metallic salt, and afterwards forcing into the pores another solution which will combine chemically with the first and form a compound that water will not dissolve. This has failed in practice, for the reason that actual contact in the ligneous cells cannot be obtained. Surgeon General Barnes, of the U. S. Army, in his report on the preservation of wood pavements, says: "In those processes which design to fill the pores of the wood with insoluble substance (formed by a rearrangement of several chemical compounds), the reaction which occurs is only partial, and confined to the superfices, being hindered by the formation of the insoluble salt, at and near the surface. * * * * My experiments show that it is always possible to dissolve and remove entirely any mineral or metallic salt which may have been deposited, with any degree of thoroughness, throughout a paving block."

It is unnecessary to multiply authorities on this point. It may be considered as a settled fact that none of the metallic or mineral salts injected into timber will preserve it from the attacks of the marine worms. It is proper to add here, however, that some of the solutions referred to will prevent decay, and can be economically applied. Sulphate of copper, applied as proposed by Thomas C. Wallace & Co., has been successfully used for the treatment of railroad ties and other timbers, both in the United States and Europe. The end of a green stick is inclosed in a close fitting collar, to which is attached an impervious bag, communicating through a flexible tube, with a reservoir containing the solution, elevated to a height of from thirty to forty feet. Hydrostatic pressure soon expels the sap and other fermentive matters at the opposite end of the stick. When the solution makes its appearance, also, the process is completed.

In eighteen hundred and forty-six, eighty thousand sleepers of the most perishable wood, impregnated with sulphate of copper, were laid down on French railways. After nine years exposure, they were found as perfect as when laid. The experiment was so satisfactory that most of the railways in France at once adopted the system.

It is claimed that this method of applying the material accomplishes two objects—that of expelling the sap, and filling the pores with a preservative solution. The invention seems to be confined to the method of applying the solution; Messrs. Wallace & Co. offering, in their communication, to treat piles and timber with creosote oil, sulphate of copper, or any other well known solution. If creosote oil, or the dead oil of coal tar, can be forced into piles by this apparatus, which I doubt, the process will give very satisfactory results.

THE CREOSOTING PROCESSES.

Creosote oil, or dead oil, as it is usually termed in the United States, is, so far, the only substance met with that furnishes a complete and perfect protection against the marine worm. It is obtained by distillation, from ordinary gas tar. In the Eastern States, forty barrels of tar will yield two barrels of benzine, ten barrels of dead oil, and about twenty-seven barrels of pitch. The benzine sells there at twenty-five cents, the dead oil at nine cents, and the pitch at thirteen cents per gallon. At nine cents per gallon, about one cent per pound, dead oil is the cheapest known material for the preservation of wood, and is also the best. The first successful application of creosote oil was made by Mr. John Bethell, who obtained a patent for his process in England in eighteen hundred and thirty-eight. In his pamphlet, Mr. Bethell thus describes his process:

"The timber, being first dried, and cut according to pattern required, is carefully weighed, and is then placed in a cylinder of wrought iron, the doors of which are hermetically closed. The air and moisture contained in the wood are then exhausted from it and from the cylinder containing it, by a powerful air pump. The pores of the wood being now empty and capable of being absolutely filled, the preservative material, called creosote oil (which consists of the heavy bituminous oils distilled from gas, tar, and pitch), heated up to one hundred and twenty degrees Fahrenheit, is forced into the body of the timber by powerful hydrostatic pumps, exerting a pressure of one hundred to two hundred pounds per square inch. This pressure is maintained until it appears that the proper quantity of creosote oil has entered the wood. The wood is then taken out and weighed, to verify the result."

He states that the amount of oil required for railway sleepers, bridges, etc., is seven pounds to the cubic foot, and for marine purposes, ten pounds to the cubic foot.

Mr. Moir, in the paper before referred to, states: "In no case does the evidence regarding the value of the process seem to equal that in favor of the creosoting process, patented by Bethell. * * * Creosote acts very powerfully in coagulating the albumen contained in the cells of the wood, and besides this, it effectually preserves the fibre of the timber, and hence its value over all other so-called preservative agents.

"Since the creosoting process was first introduced, in the year eighteen hundred and thirty-eight, it has been extensively employed in Great Britain and Ireland; in all the other countries on the continent where creosote oil can be obtained—France, Holland, Belgium, Germany, Spain, Portugal, and Italy; and in India, Cape Colony, Brazil, and other tropical countries—to preserve timber from the attacks of the white ant. Wherever it has been properly carried out, it has been completely successful."

Mr. Brunel, Robert Stevenson, Thomas McClean, A. Forrestier, M. Crepin, T. E. Harrison, Mr. Hawkshaw, and many other eminent engineers and scientific men, concur in this estimate of the value of the creosote process.

Dr. Letheby, the celebrated English chemist, states that creosote acts as a preservative agent in the following ways:

1. It coagulates the albuminous substances and gives stability to the constituents of the cambium and cellulose of the young wood.

2. It absorbs and appropriates the oxygen which is within the pores of the wood, and so checks, or rather prevents, the eremacausis of the ligneous tissue.

3. It resinifies within the pores of the wood, and in this way shuts out both air and moisture.

4. It acts as a positive poison to the lower forms of animal and vegetable life, and so protects the wood from the attacks of fungi, acari, and parasites.

Under date of December tenth, eighteen hundred and seventy, General Q. A. Gilmore, United States Army, in communication to General A. A. Humphreys, Chief of Engineers United States Army, writes as follows:

"After a careful inquiry concerning the various methods of preserving timber from decay, and from attacks of land and marine worms, now practiced, I am convinced that the Bethell process, patented in England in eighteen hundred and thirty-eight, and the two American modifications of it, known respectively as the Seely and Robins process, are both cheaper and more effectual than any other preservative methods now in use. They consist in impregnating the timber to a greater or less degree with carbolic acid, contained in creosote of coal tar."

General T. J. Cram, of the United States Engineer Corps, while in charge of the improvements of the St. Clair Flats, in Michigan, submitted to General Humphreys an interesting report on this subject, from which I copy the following tables:

Results of creosoting wood for railroad ties in foreign countries, compared with duration of the same wood uncreosoted, for ties.

NAME OF RAILWAY AND AUTHORITY FOR THE EXPERIMENT.	Kind of wood creosoted and used for the ties and longitudinal timbers.....	Period of years in use after creosoting.....	Condition at expiration of that period....	Period of duration for the same purpose uncreosoted...
Manchester and Crewe R. R..... Building News, July 5, 1870.	American white fir.	32	Perfectly sound.	Not stated.
Cologne and Minden R. R..... G. Freme, Inspector.	Not stated.	12	Perfectly sound.	4
India Railroads..... Mr. Burt.	Not stated.	20	Perfectly sound.	Not stated.
Stockton and Darlington R. R..... Thos. Summerson, Inspector.	Yellow pine.	26	Perfectly sound.	6½
Yorkshire and Lancashire R. R..... James Price.	Not stated.	24	Perfectly sound.	Not stated.
Middleborough & Great Western R. R. James Price.	Red Baltic fir.	9	Perfectly sound.	Not stated.
Great Eastern R. R..... Samuel Dawson, Superintendent.	Scotch fir.	16	Perfectly sound.	Not stated.
Belgium Railroads..... Minister of Public Works.	Red pine, oak, beech.	19	Perfectly sound.	Not stated.
Austrian, French, Prussian, and Russian Railroads..... George Sheppard Page.	Baltic fir.	20	Perfectly sound.	4

Results of creosoting wood in foreign countries for props in collieries, compared with the duration without treatment.

PLACES OF EXPERIMENT AND AUTHORITY.	Kind of wood creosoted and used.....	Period of years in use after creosoting	Condition at expiration of that period...	Period the wood lasts without creosoting .....
South Durham colliery..... Adam Hackworth, overseer.	Not stated.	15	Perfectly sound	¾ of a year.
Tanfield Moor colliery..... James Joicy & Co.	Larch.	7	Perfectly sound.	1½ years only.
Mickley colliery ..... Mathew Liddell.	Larch.	14	Perfectly sound.	6 years.
	Scotch fir.	14		4 years.

Result of creosoting for marine works.

PLACES OF EXPERIMENT AND AUTHORITY.	Kind of wood creosoted.....	Period of years in use after creosoting	Condition at expiration of that period...	Period the wood would have lasted uncreosoted before destruction by worms.....
Ostend harbor..... L. Crepin, Engineer, etc.	Baltic fir.	7	No attack. Sound.	2
Leith pier and harbor..... Thomas Maclane, Engineer.	Not stated.	12	No attack. Sound.	3½
Docks at Monk Wearmouth..... A. Forestier, Engineer.	Yellow pine.	20	No attack. Sound.	Not stated.
Tiegnmouth ..... Mr. Brunel, Engineer.	Not stated.	7	No attack. Sound.	Not stated.
Grimsby ..... Edam Smith, Engineer.	Not stated.	7	No attack. Sound.	3
Portland breakwater..... John Code, Engineer.	Not stated.	4	No attack. Sound.	3

In reference to the foregoing tables, General Cram remarks: "It is to be observed that at the expiration of the periods expressed in the third columns of the tables the timber which was treated is reported perfectly sound. There is no evidence showing how much longer it will last, and I can find no evidence of any which has been creosoted having yet decayed, or having been attacked by worms."

Upon General Cram's recommendation, the Government adopted the Seely process for the treatment of all the timber used in the improvement of the St. Clair Flats.

This process consists in subjecting the wood to a temperature above the boiling point of water, and below three hundred degrees Fahrenheit, while immersed in a bath of creosote oil, for a sufficient length of time to expel the moisture. When the water is thus expelled the pores contain only steam, and the hot oil is quickly replaced by a bath of cold oil, by means of which change the steam in the pores of the wood is condensed and a vacuum formed into which the oil is forced by atmospheric pressure and capillary attraction. Six to twelve pounds of creo-

sote oil to the cubic foot of wood is expended in this process, the amount depending on the use to which the wood is to be put. For piles or other timber exposed to the depredations of worms, twelve pounds is used.

In eighteen hundred and seventy-one Mr. Calvin Brown, Civil Engineer, and Messrs. Hanscom and Varney, Naval Constructors at the Mare Island Navy Yard, were instructed by the Navy Department to examine the Robins process for preserving timber. Under date of July twenty-first, eighteen hundred and seventy-one, they made a report to the Department, approving of the process, and recommending that it be applied to all timbers used at the yard for the upper part of ships frames, to keelsons, ceilings, clamps, beams, knees, etc.; also, to soft wood work for magazines, store-rooms, and cabins; to masts, spars, and all wood work for boats. They also recommended that it be applied to all materials required for piling, capping, planking, etc., for wharves and foundations, and, in a word, to nearly all timbers and lumber used for any purpose at the yard.

Accompanying the report is a concise history of experiments made by them to determine the influence of the process on the strength of wood, and as to combustion by fire. Also, the result of their investigations to determine the influence of the process in preserving timber from decay, and from the attacks of the *teredo navalis*. On this latter point they say:

"We visited the establishment of the Pacific Mail Steamship Company, in San Francisco, where we saw interesting evidence of the efficacy of the process in preserving piles from the destructive operations of the marine worm. A pile of Oregon pine, seven and a half inches in diameter, had been prepared expressly for this experiment by being first split through its center in its whole length in two portions. One of these portions was preserved in the usual manner of other timber, and the other left in the natural state. The two parts of the pile were then hooped together, the cleaved surfaces exactly fitting each other, and placed under water in a vertical position, being securely bolted to a stationary pile of the company's wharf; the top of the prepared pile was always under high water at least three feet, and about three fourths of its entire length was constantly under water. The pile had remained in this position since July, eighteen hundred and sixty-nine, and consequently had been subjected to all the influence thereof for twenty-two months. On being taken up in our presence, and a section sawed off the lower end, the unprepared portion was found to be penetrated by several large worms, while the prepared part remained entirely sound and intact."

After citing other instances of like effect, they say: "While these experiments afford conclusive proof of the immunity of timber, thus prepared, from the *teredo navalis*, during the time mentioned, there is no doubt in our minds that a prolonged and indefinite exposure would be attended with the same perfect defense."

The following tables show the result of their experiments to determine the influence of the process on the strength of wood. It will be observed that the strength of the preserved wood in the case of California laurel is ninety-six per cent of that of unpreserved wood; in Eastern white oak eighty-eight per cent, and in Oregon pine ninety per cent. "It was shown, however, on a comparison of the final series of trials

with those first made, with wood freshly treated by the process, that the preserved specimens materially increased in its transverse strength, and in the trials with several specimens of Oregon pine, which had been preserved two years, twenty per cent more resistance to breaking weight was observed. * * * Our experiments in burning the preserved wood showed the thoroughness of the process, as illustrated in the specimens operated upon; the preserving materials had permeated the whole mass of the sticks."

EXPERIMENTS

In testing transverse strength of various woods at navy yard, Mare Island; specimens of wood one inch square, sectional area, lengths between supports, two feet.

Name of wood.	No. of pieces.	Condition.	Average breakage weight in pounds.		Average deflection when broke (in inches).
Laurel	6	Preserved	273 lbs.		1⅓
	10	do.	264 "		1½
	6	do.	375 "	297 lbs.	1⅛
	6	Unpreserved	306 lbs.		1¼
	10	do.	306 "		1⅓
	6	do.	388 "	329 lbs.	1¼
Eastern oak	9	Preserved	323 lbs.		2⅓
	6	do.	348 "	333 lbs.	1 11-12
	9	Unpreserved	290 lbs.		1⅝
	6	do.	397 "	332 lbs.	2¼
Oregon pine	1	Preserved	268 lbs.		⅝
	9	do.	300 "		1
	5	do.	354 "		⅝
	6	do.	363 "	325 lbs.	¾
	1	do.	443½ lbs.	443½ "	⅝
	* 4	do.	453 lbs.	453 lbs.	1
	1	Unpreserved	384 lbs.		1
	9	do.	349 "		1⅛
	6	do.	390 "		11-16
	6	do.	401 "	376 lbs.	11 1-16

* These four pieces Oregon pine had been preserved nearly two years.

In regard to the influence of the process in preventing the decay of wood, Messrs. Brown, Hanscom, and Varney say: "From the above facts, we are forced to admit the superiority of the prepared over the unprepared wood, in cases where exposure to earth soils exist, but to what length of time, beyond that herein observed, this superiority may be claimed, we have no means of possibly judging. We see no reason, however, for doubting that the sound condition of prepared wood may be continued many years."

The Robins process, as practiced in San Francisco, is as follows: The bark being first removed from the piles, they are placed upon cars, some forty at a time, and hauled into a tank eighty feet long, by fourteen feet high, and eleven feet wide; the doors are then closed, and steam is let into the tank, at a low pressure, for the purpose of washing out from the wood the albumen, and any fermentative deposits left in it by the

sap of the tree. After this steam washing, the wood is dried by means of a steam coil and ventilation, and is then ready to receive the oleaginous vapors. These vapors are generated from coal tar placed in a closed still, capable of holding two thousand gallons. The first products of the tar, viz: naphtha and ammoniacal water, are allowed to pass off separately. When the thermometer in the top of the still indicates a heat of two hundred and twenty degrees, the vapors are turned upon the wood and the still kept running until the same thermometer indicates a heat of four hundred and twenty degrees. The firing under the still now ceases, but it remains connected with the tank for ten or twelve hours longer, when the wood is preserved ready for use. It is hauled out the same way it went in, loading and discharging being done by steam.

It is claimed by the patentees that while the piles thus treated are not impregnated through and through when they come from the tank, yet the circumference has received a sufficient quantity of the creosote to prevent the worms from effecting a lodgment on the surface of the pile. It is also claimed by the Robins patentees that the process of impregnating the piles or square timber through and through is completed by climatic influence, aided by the penetrating nature of the oils themselves, after the wood is removed from the tank. In small timber and planking the process is completed before they are taken from the vapor bath. The patentees also claim, and prove, that the thorough impregnation of the wood in this vapor bath is only a question of time and of consequent price per thousand feet.

From what has now been shown, I think I am warranted in saying that the protection of timber against rot and marine worms is narrowed down to the question as to the quantity of dead oil necessary to be injected into the pores of the wood. As stated repeatedly by the best authorities, a well creosoted piece of timber has never been known to rot or to be eaten by worms.

Our experience in this city in the use of preserved piles, compared with the experience of English engineers, gives us the two extremes in quantity of dead oil injected into the wood.

Bethell uses for piles from ten to twelve lbs per cubic foot.
Seely (at St. Clair Flats), uses four lbs per cubic foot.
Robins uses one lb per cubic foot.

In each case the oils are those distilled from coal tar, heated above the boiling point of water, and the greater portion of them of a specific gravity slightly exceeding that of water.

While we have no complete information as to the minimum quantity of oil that may be safely used to prevent the attacks of the marine worm, I believe it is generally conceded that it is unnecessary to pursue the treatment to the extent of saturating the timber, as in the Bethell process. The American engineers—actuated by that spirit of economy which distinguishes them from their English brothers—have investigated this branch of the subject with characteristic energy and ingenuity. Mr. Herman Haupt, in an article published in "Van Nostrand's Magazine" for May, eighteen hundred and seventy-two, says:

"It is well known that the very small portion of creosote in smoke will penetrate to the interior of a ham, and cure it. The soluble portions of wood are only four per cent of its weight. If, as high authorities assert, the five thousandth part of carbolic acid will prevent putrefaction of blood, fæces, glue solution, flour paste, and other substances

liable to fermentation, the same proportion should protect the albuminous and soluble portions of wood. And if this be true, only the one hundred and twenty-five thousandth part of the weight of the wood would be required. This is less than the two hundred and fiftieth part of an ounce to a cubic foot, and more than this may be conveyed into paving blocks by the vapor process. While it seems probable that thorough saturation with oils, as in the Bethell process, is unnecessary, a much larger portion than the minimum required to prevent putrefaction would seem to be desirable."

In the same article, Mr. Haupt expresses an opinion adverse to the efficacy of the Robins process, on the ground that the moisture in the pores of the wood is not expelled by the treatment, and that the vapors of the oil cannot, therefore, penetrate to the interior of the timber. On the other hand, we have the testimony of Mr. Calvin Brown, that in the specimens examined by him, "the preserving materials had permeated the whole mass of the stick."

In eighteen hundred and seventy-one, desiring to test the thoroughness of the treatment, I obtained augur chips from a large number of piles which had been treated by the Robins process, and submitted them to Professor Carr, of the State University, for examination. The chips were separately taken, and duly labeled, at depths of one half an inch from the circumference to the center of the pile, and at various intervals between the two ends. The following letter gives the result of Professor Carr's examination:

UNIVERSITY OF CALIFORNIA,
Oakland, November 5th, 1871.

T. J. ARNOLD, ESQ.:

DEAR SIR: I have carefully examined the specimens of wood you sent me, which have been subjected to the Robins process, with the following result:

First—A large portion of the soluble nitrogenous (albuminous) matter has been removed, thus diminishing the natural tendency of the wood to decay, and facilitating the penetration of the vapors from coal tar.

Second—The coal tar vapors have penetrated from one to three and a half inches from the surface, their presence being decidedly indicated in some instances at the latter depth. The well known preservative character of these vapors, and the repugnance of that scourge of our harbors, the *teredo*, to them, indicate the value of the process, when faithfully conducted.

Respectfully yours,

EZRA S. CARR.

In some experiments recently made by me, I observed the following facts, which I have nowhere seen noticed in published works on the subject.

1. The oil penetrates the cellular tissue of the wood with great difficulty.

2. The fibrous portion of the wood takes it up readily.

3. Oil will penetrate sap wood *across* the grain, but heart wood receives it almost entirely in the direction of the grain. This fact is made very apparent by boiling wood in oil from two to three hours, and then plunging it into a bath of cold oil. It will be found that the oil has

penetrated entirely through the sap and there stopped; the heart seeming to form an impassable barrier to its further progress.

When it is remembered that we use round timber, with the sap on, for piles, these facts may afford an explanation of the success of the Robins process as applied on this coast.

In eighteen hundred and sixty-nine, the Board of State Harbor Commissioners requested Colonel William J. Lewis, then the Engineer of the Board, to examine the subject of the preservation of wood, and in June of that year Colonel Lewis submitted an able report in favor of the Robins process as applied by the company managed by Mr. I. C. Woods. The Harbor Commissioners thereupon entered into a contract with Mr. Woods to preserve the piles, caps, stringers, and a portion of the planking used in the construction of the wharf along the bulkhead between Jackson and Pacific streets. More or less of preserved piles have been used in the construction of all wharves along the sea wall since eighteen hundred and sixty-nine, though in later built wharves none of the caps and stringers have been preserved. I have recently examined the piles in the wharf between Jackson and Pacific streets, by boring with an auger near the line of extreme low water. No worms were found in the preserved piles, but some unpreserved piles, in the same wharf, driven at the same time, nearly four years ago, were found to be worm eaten. Tne examination was not as thorough as could be wished, but it showed conclusively that the treatment has been a partial if not a complete protection against the attacks of the worm. I am not prepared to say that there are no worms in these piles, but the same tests applied to the preserved and unpreserved piles, failed to develop them in the one case and did develop them in the other.

Mr. Arthur Brown, Superintendent of Bridge Construction for the Central Pacific Railroad Company, informs me that he has lately taken up and thoroughly examined some piles which were treated by the Robins process, and driven at the company's wharf near the foot of Second street, two years ago. These piles were found to be perfectly sound and free from worms, while other piles which had not been treated, driven at the same time and place, were found to be worm eaten. Worms, however, were found in a piece of sawed timber which had been treated by the vapor process.

Some months ago, Captain Cox, of the Pacific Mail Steamship Company, also informed me that he had made some experiments for the purpose of testing the value of the Robins treatment. At that time the worms had not attacked the round timber, but he had found them in a piece of sawed timber which had been imperfectly preserved by the Robins process. It is worthy of note that the company has since used piles preserved by this process in an extensive addition which has lately been made to their wharf. I am also informed that the United States Engineers are using piles treated by this process at Mare Island, Lime Point, Fort Point, and Wilmington, and that the Central Pacific Railroad Company have recently had a large number of piles preserved in this manner.

The element of time, so essential to the determination of the value of any wood-preserving agent, is wanting in the case of the Robins process, but the results which have been obtained thus far, warrant the conclusion that it is economy and sound policy to treat by this process the piles and a portion, at least, of the superstructure of the wharves here after constructed. The price now paid by the Board for piles driven

capped, and bolted, approximates fifty cents per lineal foot; the extra cost of preserving is ten cents per lineal foot. We know from experience that fender piles, unpreserved, will not last over five years; we also know that preserved piles are not materially, if at all, injured after being driven nearly four years. Now, assuming that four years is the limit of protection afforded by the treatment, it is still evident that it is economy to preserve the piles by the vapor process.

In conclusion, I desire to say that while I am decidedly of the opinion that the vapor process, as practiced by Mr. Woods, is the best that can now be procured on this coast, I believe it would be advisable to inject a larger quantity of dead oil into the timber; and should any process or treatment be offered which would accomplish that object, I would recommend the Board to adopt it, even at a largely increased cost.

Respectfully submitted.

T. J. ARNOLD,
Engineer Sea Wall.

REPORT

OF

JOHN F. SWIFT, Esq., SPECIAL COUNSEL.

REPORT.

San Francisco, July 1st, 1873.

To the Board of State Harbor Commissioners:

Gentlemen: At the time of my becoming counsel to the Board, viz: on the first day of April, eighteen hundred and seventy-three, my predecessor reported to me the condition of the then existing litigation, as follows:

In the case of the People, ex relation of the State Harbor Commissioners v. Klumpke, et al., the judgment of the Court below, in favor of plaintiffs, had been reversed by the Supreme Court, and a new trial ordered. But the remittitur had not been filed in the lower Court. The remittitur has been filed since, and the case placed upon the calendar, for trial in its order.

Three cases, each entitled James D. Walker v. the Board of State Harbor Commisioners, and numbered in their order respectively, number nine hundred and sixty-six, number nine hundred and sixty-seven, and number nine hundred and sixty-eight, had been brought in the Circuit Court of the United States, concerning certain lots of land, covered with water, claimed as held under Alcalde grant. One of them had been tried, and a decision rendered by said Court in favor of the Board and against said pretended titles.

From that decision an appeal had been taken to the United States Supreme Court, which is now pending, and will probably be reached at the October Term of the present year.

The other cases (number nine hundred and sixty-seven and number nine hundred and sixty-eight), stand in the Circuit Court to await the decision of the appellate Court in the first named case.

No preparation has been made for the argument of this case, and I would respectfully recommend that arrangments be made in that behalf as soon as possible.

The case of A. C. Webber v. the State Harbor Commissioners, in the Supreme Court of the United States, is likewise an appeal by the plaintiff, Webber, from a judgment in favor of the Board, rendered in the United States Circuit Court. That case, likewise, comes up at the October Term of the United States Supreme Court, and requires argument, to which I call your attention, and recommend that arrangements be made at once therefor.

Since I have been your counsel no new suits of importance have been instituted by the Board, and none whatever have been commenced against it.

The case of the Board of State Harbor Commissioners v. M. R. Roberts, now pending in the Third District Court, having been transferred from the Justices' Court of the City and County of San Francisco, was commenced to recover one hundred and fifty dollars for dockage of the bark Iconium. The defense relies upon the supposed illegality of the rates levied upon vessels occupying the slips between the wharves.

I count fully upon recovering judgment in due course of litigation, and collecting the sum charged.

Claims for wharfage against lumbermen, occupying portions of East street with lumber, have been placed in my hands, but as yet, I have only notified them that payment is demanded.

Unless otherwise ordered, suits will be commenced upon these claims at an early day.

JOHN F. SWIFT, Special Counsel.

FINANCIAL REPORT.

FINANCIAL REPORT.

RECEIPTS

From July first, eighteen hundred and seventy-one, to July first, eighteen hundred and seventy-three.

Front-street wharf	$34,575 61
Vallejo-street wharf	27,490 16
Pacific-street wharf	34,334 42
Jackson-street wharf	13,649 20
Washington-street wharf	12,716 01
Clay-street wharf	13,688 82
Commercial-street wharf	10,829 93
Market-street wharf	14,539 61
La Rue's wharf	14,793 25
Mission-street wharf	21,356 50
Howard-street wharf	18,395 57
East-street wharf (Mission to Howard)	12,569 73
East-street wharf (Market to Mission)	8,087 95
East-street wharf (Market to Pacific)	3,675 00
Folsom-street wharf	22,100 00
Spear and Bryant streets (Hathaway's)	17,167 41
Pacific Mail Steamship Company	21,250 00
Dry Dock (Union Lumber Association)	5,400 00
Main-street wharf	3,472 18
Steuart-street wharf	2,500 00
Broadway-street wharf	18,200 80
Vallejo-street water front (Davis to Front)	6,100 00
Battery street	3,400 00
North Point wharf	13,903 80
Alameda Ferry Company	1,770 50
Merchants' Dry Dock Company	1,800 00
Western Pacific Railroad Company	16,500 00
Second and Berry streets	3,700 00
Montgomery and Francisco streets	5,449 81
Davis street (portion of)	480 00
Carried forward	$383,896 26

RECEIPTS—Continued.

Brought forward	$383,896 26
Bay and Francisco streets	110 00
Fisherman's wharf	1,814 10
Oakland Ferry Company	278 75
Urgent repairs (received from attorney)	250 00
Legal expense (received from attorney)	12 50
Total revenue from wharves	$386,361 61
STATE WHARF AND DOCK FUND.	
Amount drawn by Commissioners, as per Orders Nos. 74 to 106, inclusive	134,584 63
Total	$520,946 24

DISBURSEMENTS.

From July first, eighteen hundred and seventy-one, to July first, eighteen hundred and seventy-three.

URGENT REPAIRS.	
Amount disbursed for repairs on various wharves, demanded by immediate necessity	$58,575 87
CLEANING WHARVES.	
Amount paid salaries of sweepers and hauling rubbish from wharves	20,625 50
DREDGING ACCOUNT.	
Amount paid for dredging, as per sundry contracts	86,237 60
EXPENSE ACCOUNT.	
Amount paid for rent of office, books and stationery, printing, advertising, etc	9,579 33
CURRENT EXPENSE OF WHARVES.	
Amount paid salaries of wharfingers and collectors	60,665 00
Carried forward	$235,683 30

DISBURSEMENTS—Continued.

Brought forward	$235,683 30
LEGAL COUNSEL.	
Amount paid salary of counsel of Board	6,000 00
SALARY ACCOUNT.	
Amount paid salaries of Commissioners and Secretaries	25,550 00
LEGAL EXPENSES.	
Amount paid expenses in connection with litigation	445 50
SEA WALL ACCOUNT.	
Amount paid salary of Engineer	8,000 00
CONSTRUCTION ACCOUNT.	
Amount paid for widening and repairing wharves under contract	48,347 03
HARBOR PROTECTION FUND.	
Amount remitted to State Treasurer	67,594 88
STATE WHARF AND DOCK FUND.	
Amount remitted to State Treasurer	129,325 53
Total disbursements	$520,946 24

RECAPITULATION.

The foregoing receipts are subdivided as follows:

Receipts for dockage, tolls, and wharfage.	$273,584 11	
Leases made by the State	53,050 00	
Rent of wharves	59,465 00	
Urgent repairs account collected by attorney	250 00	
Legal expense account returned by attorney	12 50	
		$386,361 61
Balances in the several Funds at the time of the last biennial report were as follows:		
Harbor Protection Fund	$761 95	
State Wharf and Dock Fund	$69,030 05	
		$69,792 00
Remittances to State Treasurer during the term ending July 1st, 1873:		
For Harbor Protection Fund	67,594 88	
For State Wharf and Dock Fund	129,325 53	
		$196,920 41
		$266,712 41
Drafts on the State Controller during the term ending July 1st, 1873	$134,584 63	
Balance in the several Funds July 1st, 1873:		
Harbor Protection Fund	68,356 83	
State Wharf and Dock Fund	63,770 95	
		$266,712 41

In consequence of the receipts and expenditures for the month of June being included in the report, and the balance remitted to the State Treasurer ($9,518 44) necessarily delayed, a discrepancy in the amount named may be apparent in the report of the State Controller.

Respectfully submitted.

J. A. McCLELLAND,
Secretary.

RATES OF DOCKAGE, WHARFAGE AND TOLLS

FOR THE

PORT OF SAN FRANCISCO.

RATES OF DOCKAGE, WHARFAGE, AND TOLLS FOR THE PORT OF SAN FRANCISCO,

Established by the Board of State Harbor Commissioners, July first, eighteen hundred and seventy-three.

DOCKAGE.

Vessels under ten tons, per day, fifty cents.

Vessels of ten tons and under twenty-five tons, per day, seventy-five cents.

Vessels of twenty-five tons and under fifty tons, per day, one dollar and twenty-five cents.

Vessels of fifty tons and under seventy-five tons, per day, one dollar and fifty cents.

Vessels of seventy-five tons and under one hundred tons, per day, two dollars.

Vessels of one hundred tons and under one hundred and fifty tons, per day, three dollars.

Vessels of one hundred and fifty tons and under two hundred tons, per day, four dollars.

Vessels of two hundred tons and under two hundred and fifty tons, per day, five dollars.

Vessels of two hundred and fifty tons and under three hundred tons, per day, six dollars.

Vessels of three hundred tons and under four hundred tons, per day, seven dollars.

Vessels of four hundred tons and under five hundred tons, per day, eight dollars.

Vessels of five hundred tons and under six hundred tons, per day, eight dollars and fifty cents.

Vessels of six hundred tons and under seven hundred tons, per day, nine dollars and fifty cents.

Vessels of seven hundred tons and under eight hundred tons, per day, ten dollars and fifty cents.

Vessels of eight hundred tons and under nine hundred tons, per day, eleven dollars.

Vessels of nine hundred tons and under one thousand tons, per day, eleven dollars and fifty cents.

Vessels of one thousand tons and under eleven hundred tons, per day, twelve dollars and fifty cents.

Vessels of eleven hundred tons and under twelve hundred tons, per day, thirteen dollars and fifty cents.

Vessels of twelve hundred tons and under thirteen hundred tons, per day, fourteen dollars and fifty cents.

Vessels of thirteen hundred tons and under fourteen hundred tons, per day, fifteen dollars and fifty cents.

Vessels of fourteen hundred tons and under fifteen hundred tons, per day, sixteen dollars and fifty cents.

Vessels of fifteen hundred tons and under sixteen hundred tons, per day, seventeen dollars and fifty cents.

Vessels of sixteen hundred tons and under seventeen hundred tons, per day, eighteen dollars and fifty cents.

Vessels of seventeen hundred tons and under eighteen hundred tons, per day, nineteen dollars and fifty cents.

Vessels of eighteen hundred tons and under nineteen hundred tons, per day, twenty-one dollars.

Vessels of nineteen hundred tons and under two thousand tons, per day, twenty-two dollars and fifty cents.

Vessels of two thousand tons and under twenty-two hundred tons, per day, twenty-three dollars and fifty cents.

Vessels of twenty-two hundred tons and under twenty-five hundred tons, per day, twenty-five dollars.

Vessels of twenty-five hundred tons and over, in proportion.

Vessels loading and ballasting, half the above rates.

Vessels in outside berths or in the slips, shall pay half rates of dockage.

TOLLS.

Vehicles drawn by one or more animals, twelve and a half cents.

Loads, when in excess of two tons, six and a quarter cents additional for each ton or part thereof. Except grain, flour, potatoes, and other vegetables, when in excess of two tons, five cents additional for each ton or part thereof.

Loads of lumber, when hauled on the wharf, of two thousand feet or less, twelve and a half cents.

Loads, when in excess of two thousand feet, five cents additional for each one thousand feet, or part thereof.

Extra vehicles, twelve and a half cents.

Cattle or horses for transportation, five cents each.

Sheep or hogs, one and a half cents each.

Handcarts, five cents each.

WHARFAGE.

The following articles, when landed upon the wharf, and remaining for a period not exceeding forty-eight hours, shall pay wharfage as follows:

Wood, per cord, twelve and a half cents.

Lumber, per thousand feet, ten cents.

Stone, iron, and general merchandise, per ton, six and a quarter cents.

Bricks, per thousand, ten cents.

Coal and asphaltum, per ton, ten cents.

Hay, ten cents.

Any of the above articles remaining on the wharf more than forty-

eight hours, shall pay the above rates of wharfage for each additional day, or fractional part thereof.

All goods landed upon the wharf, and taken from thence in lighters or other vessels, shall pay six and a quarter cents per ton wharfage.

All goods received or discharged by vessels lying alongside of the wharf or in slips, from or into lighters, or other vessels, shall pay five cents per ton wharfage, and lumber five cents per M.

RULES AND REGULATIONS.

Dockage to commence upon a vessel making fast to the wharf, and to conclude when she hauls out, and to pay for each day or fractional part thereof. No allowance to be made for Sundays, holidays, or rainy days.

Vessels shall rig in jib, flying jib, and spanker booms, when required by the Wharfinger, and shall also haul or change berths, at their own expense, by his direction.

No merchandise will be allowed to remain upon any wharf over night without permission of the Wharfinger, and then only at risk of the owner.

All goods remaining on the wharf after the owner or consignee has been notified to remove the same, will be removed by the Wharfinger at the expense of the owner.

All goods, wares, and merchandise shall be charged by weight or measurement, according to custom. Two thousand pounds shall constitute a ton, except coal, iron, and stone.

No load exceeding five tons shall be admitted on or off the wharves, except single packages. Driving on any wharf faster than a walk, prohibited.

Parties holding portions of the water front, under lease from the Board of State Harbor Commissioners, are obligated to charge and collect the above rates; and any person violating said rules will forfeit his lease.

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